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Self-Lubricating Fluorine Shaft Seal Material

The problem:

A multiphase seal-face material in which one phase reacts with the sealed fluid to form a boundary-lubricating film is required for liquid fluorine pump dynamic seals.

The solution:

A lubricating film is produced by reaction of fluorine with a composite of Al_2O_3 and nickel powder. The rate of nickel fluoride generation is proportional to the rate at which the fluoride is rubbed off the surface. This allows the seal to operate with the lowest possible heating which is essential for fluorine seals.

How it's done:

A flame sprayed composite of Al_2O_3 with 15-20% pure nickel powder uniformly dispersed is surface ground and lapped to standard flatness and finish. Shaft seal tests in liquid fluorine at speeds up to 5300 fpm demonstrated greatly improved coefficients of friction, improved durability, thermal shock and low wear, as well as compatibility with both liquid and gaseous fluorine. The submersion in liquid fluorine produced the reaction film of nickel fluoride which exhibits low shear strength and forms readily.

Since the coefficient of friction is equal to S/P where S is the shear strength of the surface film (nickel fluo-

ride), and P is the compressive yield strength of the substrate material (Al_2O_3), it is necessary that the S be low and the P be high in order to obtain a low coefficient of friction. The coefficient for this material when rubbing on itself would be

$$\mu = S/P \approx 35,000/425,000 \approx 0.082$$

Note:

Requests for further information may be directed to:

Technology Utilization Officer
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No patent status is contemplated by NASA.

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